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Studies on Marine Bryozoa. VII. *Hippothoa*

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STUDIES ON MARINE BRYOZOA. VII. *HIPPOTHOA*

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The purpose of the present study is to: 1, report two *Hippothoa* species from new Antarctic localities; 2, draw attention to the range of variation in time, geography and morphology exhibited by these Hippothoidae; and 3, set forth some problems as affinities, identification and possible protandry which came to light in these specimens.

SPECIAL PROBLEMS

An examination of the present collection's *Hippothoa bougainvillei* showed it to be a species which exhibited considerable variation in general appearance. It is closely allied to *Hippothoa hyalina*, a very widely disgributed, common and cosmopolitan species. In fact, some authors have considered them as one species. Some of the less rugose *bougainvillei* colonies (fig. 4) are almost indistinguishable from *H. hyalina*, while its spiny colonies (fig. 5) are readily identifiable as a distinct species. Still other *bougainvillei* colonies whose zoids are greatly crowded can resemble another genus altogether (*Cellepora*). That they are not three distinct species or variaties can be ascertained by finding intergrading types of zoids within the same colony or from the same station.

One unexpected difficulty came to light. *Hippothoa hyalina* with which *H. bougainvillei* is most likely to be confused, although often reported in the past, has not yet been studied truly critically as regards variations, measurements and behavior under different ecological and substrate conditions. Canu and Bassler (1923, p. 94) stated that *H. hyalina* proper "is a species of the cold boreal zone and never goes farther south than the 42nd parallel." As matters stand at present, *H. hyalina*, if all who reported it were dealing with the one and same species, is presumably world-wide in distribution, while *H. bougainvillei* is to date known only from the lower half of the southern hemisphere. Moreover, *H. hyalina* has a geological range from the Pleistocene to the present (Canu and Bassler, 1923). *Hippothoa bougainvillei*, the present-day species, is apparently very closely related, if not identical, with the Pheistocene *Hippothoa hyalina* var. *rugosa* of Canu and Bassler (1923, Pl. 35, fig. 9).

Another problem which came to light during the study of *H. bougainvillei* is one of a significant and peculiar regenerative condition. Marcus (1938, p. 119) reaffirmed that *H. hyalina* has male, female and asexual zoids. *Hippothoa bougainvillei* does likewise (fig. 4). However, *H. bougainvillei* exhibited another most interesting condition (fig. 3, 6), namely, of a few zoids which had two orifices set one within the other, the inner one a male, the outer one an asexual orifice, indicating that that particular zoid had served at one time as a male and at another time as an asexual zoid. Which condition came first could not be determined from the small number of such "double-duty" zoids (three) found in the collection. Although regeneration of a new polypide inside a zooecium is a well-known fact in the bryozoa, to my knowledge the present peculiar protandrous condition is singular, and is worthy of further experimental investigation in the only easily available closely related species, *H. hyalina*, by any interested worker.

Species Discussion

Hippothoa bougainvillei (d'Orbigny) 1839

(Figures 1–9, 11, 14, 16, 18, 22)

Synonymy and reported localities:—

1839. *Escharina bougainvillei.* d'Orbigny, p. 12, Pl. IV, Figs. 9–12; from the Falkland Islands.

1876. *Lepralia hyalina* var. *bougainvillei.* Busk, p. 117; Kerguelen Island.

1876. *Lepralia hyalina* var. *H* (unnamed till 1879). Busk, p. 117; Kerguelen Island.

1879. *Lepralia hyalina* var. *muricata* (see var. *H above*) and also var. *bougainvillei.* Busk, p. 197; Figs. 10, 11.

1880. *Schizoporella hyalina* var. from Santa Cruz. Hincks, p. 274, Pl. 45, Fig. 3.

1884. *Chorizopora hyalina* var. *bougainvillei.* Busk, p. 184, Pl. 22, Fig. 4; Kerguelen Island, Tristan da Cunha and other stations, to 90 fathoms' depth.

1909. *Schizoporella hyalina.* Calvet, pp. 25–26; Bay of Flandres, Schollaert, Port Charcot, Booth Wandel and Wyncke Islands, from 0 to 40 meters.

1952. *Hippothoa hyalina* (part at least?). Vigeland, p. 8, Pl. 2, Fig. 1; from a number of stations between South Georgia and Peter I Island, around the Palmer Peninsula (southern latitudes), Antarctic and sub-Antarctic.

Diagnosis:—Encrusting, hyaline to porcellanous. Zooecial front non-porous, transversely rugose usually, sometimes carinated and umbonated. Carina may develop a sub-oral and up to 4 additional peaks or umbones, blunt or sharpened to a point. Autozooecial and male zoid orifices rounded, with a U-shaped sinus proximally, but male orifice is much smaller. Condyles bicusped. Female zoid orifice hemispherical, with V-shaped sinus in the otherwise straight proximal border. Ovicell globose, salient; surface texture variable from nearly smooth to rugose to prickly and lumpy, and from almost no pores to a small number. The prickles or "spines" are usually worn down to form irregular, elevated craters or rough-edged pores. No avicularia. Short, broad, lateral interzooecial connectives sometimes quite noticeable.

EXPLANATION OF PLATE I

All figures on this plate are of *Hippothoa bougainvillei* and were made with the aid of a camera lucida.

Figure 1. Two heavily calcified zoids, the left one, with ovicell female, the right one a normal autozoid. Wall heavily rugose. Colony grew on a thick hydroid stalk from Sta. 162. Drawn to the 0.1 mm. scale above.

Figure 2. Polypide (tentacles, digestive tract, musculature) inside a lightly calcified autozoid. The loop on the extreme left is part of the calcification of the basal wall. At lower left is an interzooecial bridge or connective. Compare with figure 5. Drawn to the 0.1 mm. scale below.

Figure 3. Two zoids of medium calcification, wall lightly rugose. The top zoid is female, ovicelligerous. The bigger zoid below is apparently protandrous and very unusual in having two orifices, one within the other, the inner one male, the outer autozooecial. Shown in greater detail in figure 6. Colony grew on an algal fragment, Sta. 104. Drawn to the figure 7 scale.

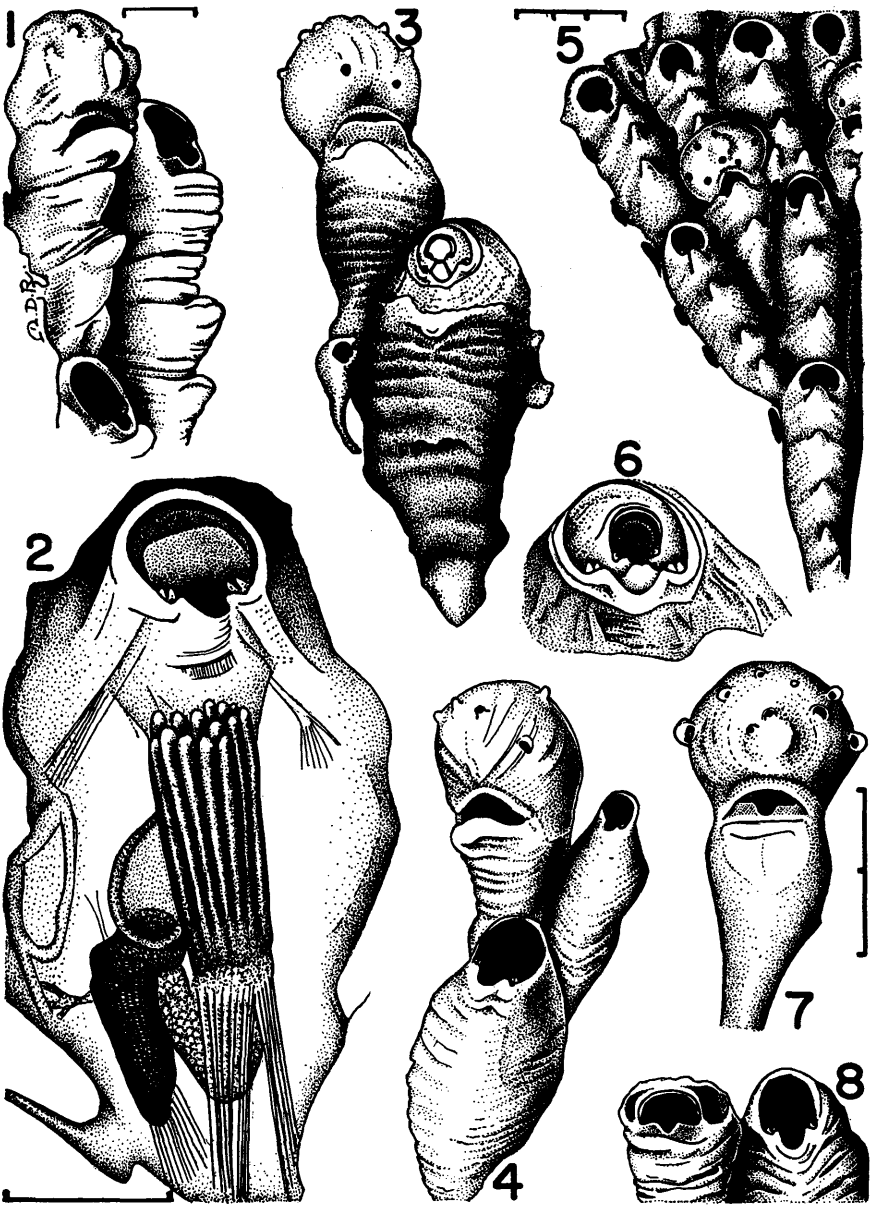
Figure 4. Three zoids, the top left a female, the small right a male and the bottom one an autozoid. Surface only lightly rugose. Drawn to the figure 7 scale.

Figure 5. Nine zoids with spinous rather than rugose fronts and interzooecial connectives separated by spaces (blackened here). The top row third zoid from left has four peaks or umbones, the bottom two above the orifice of the zoid below. From a Sta. 163 lava rock colony. Drawn to the 0.3 mm. scale above.

Figure 6. The double orifice of the protandric zoid of figure 3. Inner darkened male orifice has operculum in place. Male zoid umbo is in the sinus of the autozoid orifice. Bicusped teeth are on each side of the sinus in both orifices. Space between the two orifices is only lightly calcified. Drawn to the figure 2 scale.

Figure 7. A young ooeciozoid from the same colony as figure 3, with an ovicell that shows the thin blisters or processes (some broken through to form pores). An umbo is forming just below the orifice. Zooecial front quite smooth. Drawn to the 0.2 mm. scale at right.

Figure 8. Two zoids, female at left and autozoid at right. Orifices blackened. The ovicell is just beginning to form around the base of the female orifice. Drawn to the figure 7 scale.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Measurements:—Given below are minimum, maximum and the average of a number of readings (usually 10), in millimeters. L is for length, W for width.

0.533—0.893 (0.701) L ordinary autozooecia
0.216—0.331 (0.263) W " "
0.221—0.475 (0.384) L male zooecia
0.130—0.158 (0.144) W " "
0.274—0.619 (0.456) L female zooecia, exclusive of ovicell
0.158—0.288 (0.197) W " " " " "
0.202—0.259 (0.223) L ovicell
0.187—0.288 (0.226) W "
0.227—0.284 (0.265) L ancestrula
0.149—0.205 (0.179) W "
0.086—0.130 (0.110) L autozooecial orifice, including sinus
0.094—0.115 (0.104) W " "
0.057—0.085 (0.068) L female orifice, including sinus
0.078—0.099 (0.087) W " "
0.035—0.060 (0.048) L male orifice, including sinus
0.035—0.060 (0.047) W " "
0.064—0.074 (0.066) L ancestrula orifice, including sinus
0.057—0.067 (0.063) W " "

The measurements of zooecia were made on flat, uncrowded individuals. In occasional colonies where the space for growth is limited zoids may pile up in celleporid fashion, so that zoids are nearly upright. Sometimes a colony forms around a single sponge spicule.

Zoarium:—Colonies generally small, encrusting, unilaminate. The extreme forms may have a jagged craggy surface (fig. 1, 5). The least extreme form may be very hyaline and gently ripply (fig. 4, 7).

EXPLANATION OF PLATE II

All figures are done with the aid of a camera lucida.

FIGURE 9. An *H. bougainvillei* autozoid orifice with bicusped condyles to each side of sinus. Drawn to the 0.1 mm. scale at left.

FIGURE 10. An *H. distans* autozoid orifice with operculum in place. Unicusped condyles visible. Sinus wide. Drawn to the figure 9 scale.

FIGURE 11. *H. bougainvillei* ooeciozoid, with ovicell forming about the orifice. Strong plate-like umbo below orifice. Drawn to the figure 16 scale.

FIGURE 12. Autozoid and female zoid (ovicelled) of *H. distans*. Drawn to the figure 16 scale.

FIGURE 13. *H. distans* autozoid with polypide (tentacles, gut, muscles) inside. Drawn to the figure 16 scale.

FIGURE 14. *H. bougainvillei* autozoid operculum. Chitinous rim in black, sclerites at sides, close to chitinous rim. Drawn to the figure 9 scale.

FIGURE 15. *H. hyalina* autozoid operculum from Woods Hole, Mass. material. The two sclerites are a bit farther from the edge than those of *H. bougainvillei*. Drawn to the figure 9 scale.

FIGURE 16. Well calcified ovicell of *H. bougainvillei* with the blister or spinous processes broken off to form pores. From Sta. 163 rock. Drawn to the 0.1 mm. scale above.

FIGURE 17. *H. hyalina* ooeciozoid operculum from Woods Hole material. Sclerites at sides. Drawn to the figure 9 scale.

FIGURE 18. *H. bougainvillei* male zoid orifice, with the bicusped condyles, drawn to the figure 9 scale.

FIGURE 19. *H. distans* ooeciozoid operculum. Sclerites at sides. Drawn to the figure 9 scale.

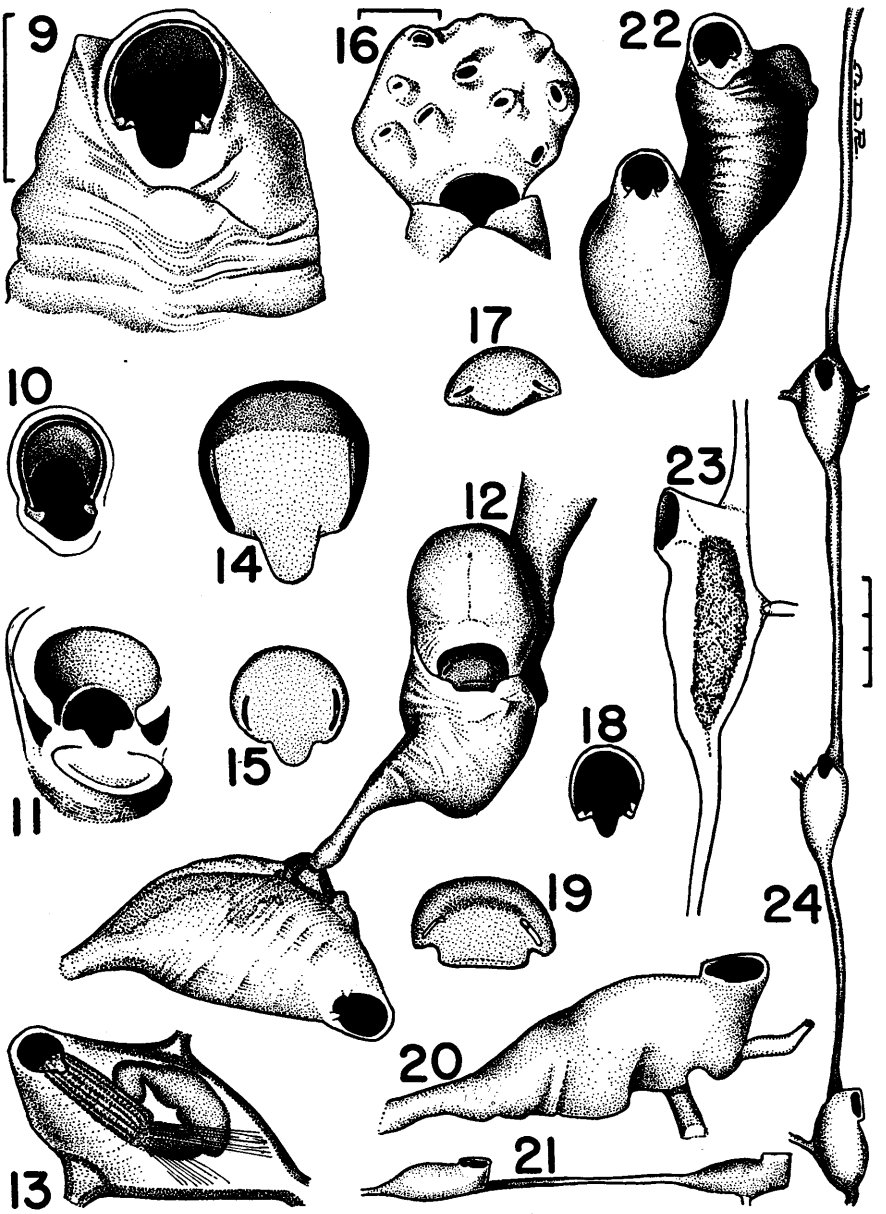
FIGURE 20. *H. distans* autozoid with very irregular sides and base. Two other zoid stalks arise from it. Drawn to the figure 16 scale.

FIGURE 21. Typical *H. distans* autozoids in profile, one with side branch. Plane of orifice parallel to plane of base. Drawn to the figure 16 scale.

FIGURE 22. Smooth oval ancestrula and a lightly rugose autozoid of *H. bougainvillei*. Drawn to the figure 16 scale.

FIGURE 23. *H. distans* zoid in profile, with tentacle sheath and polypide remains. Base more typical than figure 20. Drawn to the figure 16 scale.

FIGURE 24. Unusually long *H. distans* zoids. Drawn to the 0.3 mm. scale at right.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Zooecia:—Three easily recognizable kinds of zooecia (fig. 4), female, male and autozoids, are present in a colony. A protandrous transformation may possibly occur in at least two of these zoid types. Three zoids, with double orifices (a male orifice inside an autozoid orifice, pictured in fig. 3 and 6) were seen, indicating that those particular zoids had functioned either as male or as ordinary (non-sexual?) zoids, at different times. Unfortunately it was impossible to determine which condition was the preliminary one.

The zooecial surface is transversely corrugated. A keel may develop in some zoids. A suboral umbo is generally present. In female zoids it is a distinct flap partly concealing the orifice (fig. 1, 3, 11). The few other hollow umbones may be slight, mound-like or may rise to sharp peaks, along the median longitudinal frontal axis. Occasional zoids develop a pair of umbones near the two lower proximal corners, just above the orifice of the next proximal zoid (fig. 5).

The back wall is incomplete. Broad interzooecial connections exist (fig. 2, 5) between which are slit-like spaces or fenestrae. There seems to be no set pattern or consistency in their appearance.

Tentacle number was about 14 (fig. 2).

Ancestrula:—The ancestrula is like that of *H. hyalina* (see Barrois' 1877, Pl. 9, Figs. 9–16 of *Mollia hyalina*). It is oval, generally not corrugated nor keeled (fig. 22). Its orifice resembles in shape those of male and ordinary zoids.

If one disregards the sinus it can be said that the female orifice is hemispherical (fig. 8, 11) while the male and autozoid orifices are rounded to oval. The sinus is V-shaped in females, U-shaped in the others. The sinus is set off by two sharp corners from the rest of the orifice. In an incised location further to each side of the sinus is a bicusped condyle which seems to be a significant difference between *H. bougainvillei* and *H. hyalina*. The latter has unicusped condyles.

Ovicells:—The salient, globose to peaked ovicells are quite variable as to decoration. Their surface may assume any of the following conditions: nearly smooth, with a few blister-like pores; corrugated (fig. 4); umbonated (fig. 5, 7); irregular, lumpy or misshapen (fig. 16); burry or prickly, with prickles broken off or worn down to slightly elevated craters (fig. 16). The prickly ones were the least abundant and occurred mostly on a lava rock from Sta. 163. Busk at first (1879, p. 197, Fig. 11) called the prickly type var. *muricata* but later (1884, Pl. 22, Fig. 4) pictured the same type as var. *bougainvillei*, apparently relegating *muricata* to the synonymy of *bougainvillei*.

Ovicell porosity is varied. Some ovicells have almost no pores, others have a small number. The pores are irregular in size, shape and distribution. They appear as little blisters or prickles on the ovicell surface. They are generally not as large nor as close together as those of *H. hyalina*.

Avicularia and stolons:—Absent.

Distribution and ecology:—Very small amounts of *H. bougainvillei* were collected from the following Antarctic localities by Comdr. D. C. Nutt during the U. S. Navy's 1947–48 Antarctic Expedition: *a*, on Jan. 29, 1948, at 58 fathoms, from Sta. 104, off Cape Royds, Ross Island in the Ross Sea Area; *b*, on Feb. 15, 1948, at 30 fathoms, from Peter I Island Area Stations 149, 162, 163; *c*, from the Marguerite Bay Area on Feb. 20, 1948, at 35 fathoms from Stations 189, 190, 193, 194, —on Feb. 22, 1948, at 40 fathoms from Stations 225, 226, 229, 230, 233, 234, 236, 238, 240 and from debris entangled on a starfish from Sta. 243 (Mr. Layton collector). The species was also found in Case 1 and on pebble No. 2, collection data lacking. Material from most of these stations is deposited in the U.S. National Museum. The colonies grew on various substances: algae, pebbles, sponge spicules, hydroid stems and assorted bryozoans. Some of the latter are: *Camptoplites latus* (Kluge) 1914 and *Camptoplites retiformis* (Kluge) 1914 of Sta. 230; *Carbasea tenuis* (Kluge) 1914 and *Flustra flagellata* Waters 1904 of Sta. 226; *Himantozoum antarcticum* (Calvet) 1909 of Stations 149, 226; *Notoplites drygalskii* (Kluge) 1914 and *Escharoides bubeccata* (Rogick, 1955, p. 442), of Sta. 104.

The frontal surface of the *bougainvillei* colonies was usually very clean, not overgrown with other species. However, some colonies from a lava rock from Sta. 163 were partly overgrown by a colony of *Escharoides tridens* (Calvet) 1909. A few embryos were present in the

ovicells growing on a hydroid stalk from Sta. 162 (Feb. 15). A number of ancestrulae with young as well as advanced colonies came from Sta. 226. Most of the material consisted of empty colonies or colonies which had few living polypides at the time of collection.

Hippothoa distans MacGillivray 1869

(Figures 10, 12, 13, 19, 20, 21, 23, 24)

Synonymy and reported localities:

1869. *Hippothoa distans*. MacGillivray, p. 130; Australia.
1870. *Hippothoa flagellum*. Manzoni, p. 328, Pl. 1, Fig. 5; Pliocene fossil from Italy; and live from the Mediterranean, (Manzoni, 1871, according to Hincks, 1880, p. 293).
1880. *Hippothoa flagellum*. Hincks, p. 293, Pl. 44, Figs. 5–7; Cornwall, Guernsey, South Devon, Shetland, etc.
1884. *Hippothoa flagellum*. Busk, p. 4, Pl. 33, Fig. 7; off Heard Island, 75 fathoms.
1889. *Hippothoa distans*. MacGillivray, pp. 321–322, Pl. 187, Figs. 10–13. (Illustrations of the species whose description was made in 1869.)
1938. *Hippothoa distans*. Marcus, pp. 212–213. Excellent for synonymy and distribution.
1952. *Hippothoa distans*. Brown, pp. 203–204. More synonymy and distribution records.
1952. *Hippothoa flagellum*. Osburn, Pl. 30, Figs. 7–8, p. 278. Pacific coast of Mexico and South America.

Diagnosis:—Colony encrusting, diffuse; branching open, lateral and longitudinal. Zooecia small, hyaline, non-porous, greatly prolonged and narrowed proximally. Plane of autozooecial orifice parallel with the attached dorsal zooecial surface. Ooeciozoids smaller, their orifice wide, with very shallow broad sinus. Ovicells non-porous, unadorned, mitriform. Autozoid orifice narrow, ovate, with two unicusped condyles limiting the sinus.

Measurements:—H is for height, D for diameter.

0.326—0.531 (0.404) L autozoid "body" exclusive of the proximal prolongation or "stolon"
0.149—0.234 (0.183) W autozoid "body" or swollen part
0.113—0.142 (0.128) H autozoid, from substrate to plane of orifice
0.326 (only one) L female zoid, exclusive of ovicell
0.453 L female zoid, including ovicell
0.148—2.035 (0.958) L of "stolon" or proximal extension of zoid
0.021—0.032 (0.026) D of "stolon" or zoid extension
0.184 L ovicell
0.149 W " "
0.064—0.078 (0.072) L autozooecial orifice, including sinus
0.044—0.071 (0.059) W " "
0.060 L female zoid orifice, including sinus
0.081 W " " "
0.053 W female zoid orifice sinus
0.011 H " " " "
0.028 W. autozoid sinus

Priority problem:—The question of the correct name, date and author still persists. The reason for it is that MacGillivray's original description (presented during the Nov. 26, 1868 session of the Royal Society of Victoria and published in Jan. 1869) was unaccompanied by illustrations. For some reason he was in a great hurry to publish descriptions of 48 new species of bryozoa without accompanying illustrations. He stated that the illustrations were to appear in the forthcoming or projected "Memoirs of the Museum" under McCoy's direction. Forty-four of these 48 species were eventually illustrated in McCoy's "Prodromus" which appeared from 1878 to 1890. *Hippothoa distans* appeared in 1889. In the meantime, Manzoni in 1870 described and figured *H. flagellum*, an Italian fossil, which to all appearances seems to be identical with *H. distans*. Some workers have used Manzoni's name in preference to MacGillivray's, but in view of all the circumstances MacGillivray's name should have priority.

Zoarium:—Colony encrusting; inconspicuous because of the small, widely spaced, pyri-

form zooecia. Zooecial branches sprout from the sides and distal end of a zoid (fig. 20, 24). The zoids are drawn out to a fine long tube proximally (fig. 24). Brown (1952) reported these slender processes to be up to 0.53 mm. long. The Antarctic specimens had a greater range, 0.148–2.035 mm.

Zooecia:—The fragile, brittle, non-porous, transparent front wall varies from smooth to faintly rugose transversely (figs. 12, 20, 21). In side view the zooecial orifice is steeply elevated, its top parallel with the substratum (fig. 21, 23). It differs from *H. bougainvillei* whose orifice is oblique with respect to the substratum (fig. 1). No male zoids were seen. Whether they exist is unknown.

Avicularia:—Absent.

Orifice:—The autozooecial orifice is similar to that of *H. hyalina*, having unicusped condyles (fig. 10). The ooeciozoid orifice has a shallow but broad sinus, intermediate between the *bougainvillei* and *hyalina* conditions (fig. 11, 12, 17, 19).

Ovicells:—Only an empty, smooth, non-porous one seen (fig. 12).

Distribution and ecology:—This species is one of surprisingly wide distribution. Previous workers have reported it from fossil deposits of Japan, New Zealand and Italy (Pliocene) and as Recent species from Australia, the Azores, Brazil, Cape Verde Islands, Europe an seas, Indian Ocean, Malaya, New Zealand, Pacific Coast of North and South America, Philippines, the Tortugas and other localities. Waters (1904, p. 55) reported it from several Antarctic stations from depths of 480 to 569 meters. The U.S.N. specimens came from the following Antarctic stations: 104 and 190. Station 104 was farther south (about 77°30′S. Lat. and 166°E. Long.) than those of Waters (70°23′S. Lat., 82°47′W. Long.; and 70°15′S. Lat., 84°06′W. Long.) but considerably shallower (58 fathoms).

Most of the present specimens occurred on sponge spicules, hydroid stems, alcyonarian twigs and some on other bryozoa as *Clithriellum inclusum* and a Cribrilinid species, from Sta. 104. A smaller number occurred in the Sta. 190 material.

SUMMARY

1. Two living species, *Hippothoa bougainvillei* and *H. distans*, are reported from new Antarctic localities. *Hippothoa distans* is cosmopolitan, world-wide in distribution while *H. bougainvillei* is found only in the lower half of the southern hemisphere (Antarctic and sub-Antarctic).

2. *Hippothoa distans* is a distinct species but *H. bougainvillei* is likely to be confused with the cosmopolitan *H. hyalina*, hence its variations have been given in detail.

3. Possible problems for investigation are suggested, as protandry.

4. The question of the priority of *distans* over *flagellum* is further clarified.

5. A number of other bryozoa belonging to the genera *Camptoplites*, *Carbasea*, *Flustra*, *Himantozoum* and *Notoplites* are incidentally reported from new Antarctic localities.

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